Review Article

Modalities in the activation of sodium hypochlorite: A review

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ABSTRACT

In endodontics, a complete chemo mechanical cleansing of the root canal system which is complex is required and is the key to achieve therapeutic success. Sodium hypochlorite (NaOCl), with its antimicrobial and proteolytic characteristic, is an efficient endodontic irrigant, and it is the most commonly used irrigant. There are various methods to activate the root canal irrigant such as using large amounts of NaOCl, preheating and also using sonic and ultrasonic cases. The main goal of the root canal treatment is to completely eliminate the different components of the pulpal tissue, calcification, and bacteria, the placement of a hermetic seal to prevent infection or re-infection and to promote healing of the surrounding tissues if needed. There are many techniques available to accomplish the root canal preparation. There are also many techniques for filling the root canal system (i.e., vertical compaction of warm gutta-percha, System B, and lateral condensation). NaOCl has many desirable qualities and properties. It performs bactericidal cytotoxicity, dissolution of organic material, and minor lubrification. The aim of this survey is to systemically study the various modalities used in the activation of NaOCl.

KEY WORDS: Activation modality, Endodontics, Irrigant, Irrigation, Root canal, Sodium hypochlorite

INTRODUCTION

The root canal treatment basically encompasses a combination of both mechanical instrumentation and also a chemical debridement of the complex root canal system, followed by filling it up with an inert material that will help to restore the health of the periradicular tissues. The treatment of the root canal system is not standardizable because the treatment procedures are so vast and diverse that it is not possible to execute it with prescribed protocols and therefore there is no specific treatment intervention. The treatment is decided by the complexity of the anatomy of the tooth and also the state of biology it is in which is known as the preoperative status. The procedure of root canal can be used to treat two different disease entities (i)a diseased pulp which is still vital and the goal here is to prevent further periapical disease or (ii) a nonvital as well as a dying pulp associated with periapical disease. The main aim of the treatment is to restore all the affected tissues back to health. The basic goal of the root canal treatment is to treat and restore any of the affected periapical tissues; this statement encompasses a vast diversity of possibilities that are wholly still not recorded. The aims of this review are to explore the various modalities available in the current world of dentistry for an efficient root canal treatment and to gain an idea of various treatment modalities available for the efficient irrigation or cleaning of the canals.[1-6]

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SUCCESSFUL OUTCOMES OF A ENDODONTIC TREATMENT

An endodontic treatment is considered successful and is universally accepted only depending on these factors:

1. Cleaning and shaping of the canals.
2. Disinfection of the canals.
3. Obturating the root canal system three-dimensionally.

CLEANING AND SHAPING OF THE ROOT CANALS

To ensure proper cleaning of the root canal, it is very important to completely remove the roof of the chamber. The removal of the roof of the chamber leaves way to remove all of the pulp tissue, residues, the calcifications that might be present. This is usually achieved by the

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proper access opening without which there will be no proper cleaning of the complex root canal system.[7] There can be two consequences of the access opening:

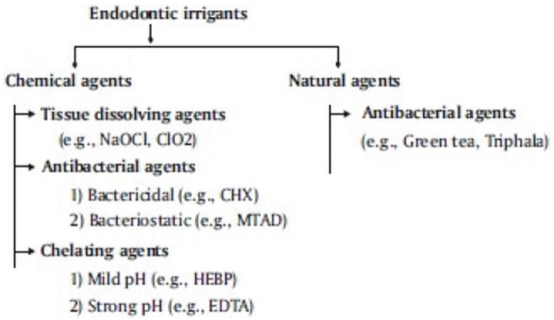
1. There can be cross-contamination of the same canal that the dentist has gained access to.
2. There are chances of discoloration of the teeth that are being treated especially if it's the anterior teeth that are being treated.

It should be made sure that the entire floor of the root canal is visualized because it helps in identifying the opening of the root canals especially when it comes to posterior teeth, as the floor of the posterior teeth has natural grooves and at the end of the grooves is the orifices of the canal. To enable proper location of the orifices of the canal, the access gained is modified to give it "convenient shape." The anterior walls of the teeth are given an anterior inclination, which gives way to proper inspection of the canals. The visualisation of the canals is made using the endodontic probe. Using an endodontic probe, it is possible to reach the opening of the canals and also helps in clearing any obstructions such as calcifications.[7-15] The success of a root canal treatment mainly depends on the proper use of instruments, irrigating the canals properly, and obturation the canals properly. The major step of this three is the irrigation of the root canal because this step determines the healing of periapical tissues. The predominant goal in the root canal treatment is to achieve root canal disinfection and also to completely stop or prevent reinfection from happening.[16] The debridement of the local wound in the pulp which is diseased is the major step in root canal treatment; this will help the tooth from being the main source which causes the infection. There are certain requirements for an ideal irrigant. Sodium hypochlorite (NaOCl) is one of the most commonly used irrigant in endodontics. Because NaOCl is known to express a vast antimicrobial spectrum and they are very ideal for the dissolution of the necrotized tissues. In addition to irrigants, chelating agents are also suggested that can act as adjuncts for the irrigants, which will prevent the formation of a smear layer.[17,18]

REQUIREMENTS OF AN IDEAL IRRIGANT

1. The irrigant should have a broad antimicrobial spectrum
2. The irrigant should have high efficiency of action against the various anaerobic and facultative microorganisms which are seen in biofilms
3. It should completely dissolve the necrotized pulp tissues
4. It should have the ability to inactivate and nullify the effects of the various endotoxins released by the microorganisms
5. It should prevent the formation of a smear layer
6. It should cause minimal or no damage when they come into contact with the other vital tissues.

CLASSIFICATION OF IRRIGANTS



NaOCl

The NaOCl is the most efficient root canal irrigant and is popular even today right from the beginning of its usage ever since World War I. It has an extensive history of antimicrobial spectrum in both medicine and dentistry.

Mechanism of Action

$NaOCl+H_2O \leftrightarrow NaOH+HOCl \leftrightarrow Na^+ + OH^- + H^+ + OCl^-$

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Properties of NaOCl

Principal ingredient of NaOCl is unbound chlorine; solution must be replenished frequently during preparation to compensate for lower concentrations and to constantly renew the fluid inside the root canal. When canal is narrow and small, files must carry the NaOCl to the apical third during instrumentation. Bacteria inside main root canal, lateral canals, and dentinal tubules - if in direct contact with irrigant - are destroyed. NaOCl reacts with fatty acids and amino acids in dental pulp resulting in liquefaction of organic tissue. There is no universally accepted concentration of NaOCl for use as an endodontic irrigant. 1% solution is effective, at dissolving tissue and providing an antimicrobial effect. 6% commercial household bleach undiluted can cause substantial necrosis of wound area and may result in serious clinical side effects. Diluted 1:1 or 1:3 ratio with water, i.e., 2.5% or 1% solution suitable for clinical endodontic use.[19-25]

Factors Affecting the Action NaOCl

- Use of NaOCl in full concentration of 5.52%
- Canal size and access
- Syringe type
- Heating the solution
- Activation with ultrasonics.

Concentration and Time

The most efficient irrigation of the root canals can be achieved using 1.3% and 2.5% of NaOCl at a

efficiency rate of 5.25% for about 40 min. NaOCl is comparatively less effective in acting against the endotoxins released by the various microorganisms but was active against the bacteria present in the root canals.[26-28]

Effect of NaOCl against the Biofilm

1. The cells are completely dissolved and are absent on visual inspection
2. The cells of the bacteria are no longer viable
3. The bacterial cells detach themselves from the biofilm
4. Even the few cells, which are present in the biofilm, are nonviable
5. There are few bacterial cells that get detached from the biofilm, but still, they are viable
6. Few bacterial cells stay adhered to the biofilm and are viable

Measures to Increase the Efficiency of NaOCl

By altering the pH

The antimicrobial and the residual tissue dissolving properties of NaOCl decreases when the concentration of it is altered. When NaOCl is added to water, then the following reaction will occur:

$NaOCl + H_2O \rightarrow NaOH + HOCl$ (hypochlorous acid)

$HOCl \leftrightarrow H^+OCl^-$

The HOCl ion which is produced as a result of the dilution of the NaOCl is considered to be the reason for its chlorinating and oxidizing property on tissues and on microorganisms.[29-31] The HOCl ion which is generated as a result of the dilution of NaOCl is a better and a stronger oxidant than the hypochlorite ion. The antimicrobial activity decreases with higher pH.

By altering the temperature

By altering the temperature of NaOCl, the efficacy of NaOCl can increase. By increasing 25°C, the efficacy of NaOCl was observed to be increased. The amount of tissue dissolving properties was found to be increased when the temperature is increased, i.e., the action of 1% NaOCl at 45°C was equivalent to 5.25% solution of NaOCl at 20°C.[32]

Ultrasonic Modifications

The ultrasonic modification of NaOCl can be achieved with or without the use of ultrasonic instruments. Passive ultrasonic irrigation is defined as the irrigation technique when canal shaping is not undertaken. The passive ultrasonic irrigation can be achieved with a small wire or a small file. The size of the file ranges from size 10 to size 20. The file should be able to oscillate free in the space of the root canal because that will induce, more powerful microbial acoustic microstreaming. The passive ultrasonic irrigation can be a better alternate in cleaning of the complex root canal system, especially when compared to the conventional syringe irrigation. Its been observed to remove comparatively more of the remanant tissues shows increased antimicrobial property and clears any debris on its way. Passive ultrasonic irrigation has also proved to be a better irrigant than being irrigated using ultrasonic instruments simultaneously. Passive ultrasonic irrigation is efficient even in curved canals. For determining the efficacy of the damaged dentin, debris removal, and the antimicrobial property, the taper, and the diameter of the root canal were considered. Moreover, the use of ultrasonic modification seemed to increase the activity and effectiveness of 5% NaOCl, especially in the canal wall. When the passive ultrasonic irrigation was done with a Ni-Ti tip, it produced superior tissue dissolving properties when compared to the irrigation which involved the simultaneous use of sonic instruments for irrigation.[33]

Influence on Mechanical Properties

NaOCl is a productive natural dissolvable that causes dentin degeneration due to the disintegration of collagen by the breakdown of the bonds between carbon particles and disruption of the protein essential structure. The decrease of the bond quality seen between glue frameworks and dentin dividers might be a result of the expulsion of collagen fibrils from the dentin surface by NaOCl, hindering the development of a steady half and half layer.

Influence of NaOCl on NiTi

Busslinger and Barbako assessed consumption of endodontic records caused by NaOCl arrangements of various focuses from 0.5% to 5.5%. These creators inferred that the amounts of particles discharged by the erosion procedure into the NaOCl arrangements were inconsequential. Thusly, no noteworthy consumption of NiTi documents in these arrangements was distinguished. Fabiola *et al.* proposed that introduction to 5.25% NaOCl arrangement influences neither protection from flexural weariness nor torsional protection of NiTi K3 endodontic records. Influence of NaOCl on bond strength[34-37] NaOCl water system prompts diminished bond quality among dentin and tar concretes and may require an inversion operator due to its capacity to influence the polymerization of the tar sealer Agents, for example, ascorbic corrosive or sodium ascorbate have been appeared to totally turn around this lessening in bond strength with interaction of NaOCl and chlorhexidine (CHX).[38] Kuruvilla *et al.* recommended that the antimicrobial impact of 2.5% NaOCl and 0.2% CHX utilized as a part of blend was more noteworthy than that of either specialist utilized independently. The response among NaOCl and CHX produces a cancer-causing item, parachloroanaline (PCA), the potential spillage of which into the encompassing tissues is a worry. The hasten is an

insoluble impartial salt shaped by the corrosive base response among NaOCl and CHX. PCA is the principal result of the cooperation of NaOCl and CHX and has the sub-atomic equation NaC6H4Cl when blended with NaOCl, CHX particles move toward becoming hydrolyzed into little sections, each shaping a side effect. The main bonds to be softened up this response are those among carbon and nitrogen as a result of the low-bond separation vitality between these two iotas. The nearness of PCA was affirmed by the Beilstein test for the nearness of chlorine and the HCl dissolvability test for the nearness of aniline. Filtering of PCA from the insoluble encourage shaped is of concern since it has been appeared to be cytotoxic in rats and potentially cancer-causing in humans. This response coats the waterway surface and essentially blocks the dentinal tubules and influences the seal of the root canal.

OTHER MODALITIES FOR EFFICIENT IRRIGATION

Methods of Activation

Syringes

Plastic syringes of size 1–5 ml are widely used. Luer-Lock design syringes are much preferred. Separate syringes should be used for each solution because some irrigating agents may react with each other.

Needles

Smaller needle sizes are preferred. Sizes like 27G 30G are widely used nowadays. Studies have shown that the irrigant has only a limited effect beyond the tip of the needle because of the dead-water zone or sometimes air bubbles in the apical root canal, which prevent apical penetration of the solution.

EndoActivator

EndoActivator (Advanced Endodontics, Santa Barbara, CA, USA) is a new type of irrigation facilitator. It is based on sonic vibration (up to 10,000 cpm) of a plastic tip in the root canal. The system has three different sizes of tips attached to the handpiece that creates the sonic vibrations. EndoActivator does not give new irrigant to the canal, but it helps in the penetration of the irrigant in the canal. Two recent studies have indicated that the use of EndoActivator facilitates irrigant penetration and mechanical cleansing compared with needle irrigation, with no increase in the risk of irrigant extrusion through the apex.[39]

RinsEndo

The RinsEndo system is based on a pressure-suction mechanism with approximately 100 cycles per minute.[40]

EndoVac

EndoVac uses the method of suction of irrigating agent from the pulp chamber to the root canal and back to the needle. It lowers the risks associated with irrigation close to the apical foramen considerably. Another advantage of the reversed flow of irrigants may be good apical cleaning at the 1 mm level and a strong antibacterial effect when hypochlorite is used, as shown by recent studies.[41]

Ultrasound

Analysis of the physical mechanisms of the hydrodynamic response of an oscillating ultrasonic file suggested that stable and transient cavitation of a file, steady streaming, and cavitation microstreaming all contribute to the cleaning of the root canal.[42] Free movement of the ultrasound files must be present in the canal without any contact to the wall of the canal for maximum effect. Van der Sluis *et al.* said that a smooth wire during ultrasonic irrigation is as effective as a size 15 K-file in the. Ultrasonic tips will reduce the operative side effects and damage to the surrounding tissues.

CONCLUSION

NaOCl is the most common root canal irrigation solution. The various way of activation of NaOCl is mainly divided into two namely active and passive irrigation. Passive irrigation means slow flow of the NaOCl into the root canal system and irrigate it whereas active irrigation means dynamic initiation and flow within the fluid for maximum activity in the root canal system The major methods of activation of NaOCl are ultrasonic, photoactivated disinfection, sonic, and preheated NaOCl and Er: YAG laser with an endodontic fiber tip NaOCl is a root canal irrigation agent which is widely used in endodontics for the sterilization of the root canal system. NaOCl has a bactericidal effect when administered in appropriate concentration which brings about the sterility to the root canal system. Since the root canal system is much complex and inaccessible properly, regular administration of NaOCl is not sufficient. Hence, activation of the NaOCl is done to attain the utmost effect of NaOCl. Activation can be done with various methods in which activation with ultrasonics is much commonly used whereas the activation using Er:Yag laser is found to be superior in attaining maximum efficacy of NaOCl.

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